INTERIM PROGRESS REPORT TEMPLATE

Project Title: Transitioning an assessment of impact producing east coast winter storms to decision support tools for emergency management and coastal restoration
Investigators, including full contact information

NOAA Grant Number: NA050AR4311122

Time period covered: 1 year January 2006 – January 2007

I. Preliminary Materials

A. Project Abstract

Despite total impacts that exceed those associated with tropical storms, emergency managers and coastal managers and engineers are faced with a dearth of information concerning the climatology of east coast winter storms. This proposed work leverages the unique capabilities of existing research, extension and operational centers to create decision support tools related to east coast winter storm frequency and impacts. The work has its basis in published NSF-sponsored research as well as a preliminary workshop focused on soliciting practical applications for the existing east coast winter storm climatology and empirical seasonal frequency forecast procedure.

Based on feedback from a team of stakeholders, initial research efforts will focus on segregating the existing east coast winter storm climatology into subsets depicting impact magnitude. This will allow a rating system to be devised that quantifies the potential for coastal impacts and allows for the computation of storm return frequencies that are tied to impact magnitude. Modification of existing seasonal forecasting procedures to reflect impact severity as opposed to overall storm frequency (including those with little or no impact) will also be investigated. The Cornell Department of Earth and Atmospheric Science will lead these research efforts.

Operational implementation of the climatological decision tools and potentially seasonal storm activity outlooks will be the responsibility of the NOAA Northeast Regional Climate Center. This established center will allow the operational aspects of this work to continue beyond the funding periods.

Likewise, the NY Sea Grant Program will take the lead in the extension and outreach components of the proposed work. Their efforts will be twofold, serving as both a liaison to the decision maker team as well as a mechanism for educating emergency managers and other coastal interests (including the general public) about the use of the climatological tools and forecasts. The Sea Grant program also brings expertise in effective communication of our results via both electronic and print media. The network of coastal decision makers that are accessible through Sea Grant will be instrumental in assuring the climatological tools developed will be valued and used in decision support. In addition, this network will allow for evaluation of the project based on feedback from an independent group of decision makers not initially involved in the project.

B. Objective of Research Project

The overarching objective of this work is to transition our prior work on ECWS climatology and seasonal forecasting to planning tools and products that meet the needs of emergency managers and coastal restoration engineers in the Northeast. Feedback from our decision maker panel indicates that our prior research will serve as a strong springboard for this work.

C. Approach

Achieving this main objective, will require meeting the following more specific approaches

1) **Develop coastal-impact-specific ECWS climatologies** using the original Hirsh et al. climatology as a basis
2) **Devise a rating system** to numerically classify storms based on their potential to cause coastal impacts.
3) **Compute return frequencies**, **identify trends**, and **develop relationships** to DeGaetano et al. (2001) predictor variables based on the impact-specific climatologies
4) **Tune the rating system** and impact climatologies based on decision maker experience
5) **Implement operational classification** of ECWS in real time (both forecast and retrospective)
6) **Provide prototype ECWS seasonal forecasts** to decision makers based on impact-specific climatologies and DeGaetano et al. (2001) and Chan et al. (2003) methodologies
7) **Design an interactive web site** to operationally disseminate climate and forecast products
8) **Educate emergency managers** and other coastal interests about the use of the climatological tools and forecasts
9) **Evaluate** the project based on specified performance measures

D. Description of any matching funds used for this project:

We have been able to leverage funds from four sources. Funds from the operating budget of the Northeast Regional Climate Center supported a student research assistant during the summer of 2006. Funds from this source also supported a temporary research assistant who was instrumental in establishing a template for the web site. A second student is currently working on this project as a Cornell Presidential Research Scholar. A significant portion of the funds supporting this student is provided by Cornell. During the last year, one of the investigators (DeGaetano) was also awarded NSF funds to extend his prior NSF research on storm frequency. Finally, the NY State Sea Grant Program provided state funded support for Dale Baker, the CO-PI on this project.

II. Interactions

A. Description of interactions with decision-makers

Interviews with local officials have provided a list of storm events between 1989 and 2004 for which local advisories have been issued on the south shore. Storm histories dating back to the 1900's have also been assembled from pertinent reports from state and federal agencies involved with emergency response and coastal management. Various government officials have been briefed on the study at several meetings including a Hurricane Preparedness Information Meeting hosted by New York State Assemblyman Harvey Weisenberg and the Stony Brook University's Storm Surge Modeling Group's meeting on storm surge modeling on storm surge prediction, modeling and mitigation strategies held in Manhattan. These meeting included local state and federal emergency management personnel.

Additional stakeholders have been recruited to broaden the geographic scope and range of responsibilities of the user decision team. In addition to the original members described in the proposal, other officials with emergency response and coastal planning and regulatory responsibilities have tentatively agreed to help review the tools and products in the project, including the police chief of Center Island, an incorporated village on Long Island Sound, a representative from the planning department from the Town of Riverhead, which borders both Long Island Sound and the Peconic Bay system, and the Commissioner of Conservation and Waterways of the Town of Hempstead. We are currently developing a data base of federal state and local officials which will be used in the final phase of the project to publicize and promote the website and other associated tools. An ArcIMS web server, developed under another NOAA project and located at the Sea Grant Stony Brook Office, is presently on line and available for use in this project, if necessary.

B. Description of interactions with climate forecasting community

We have not had any interactions with these groups.

C. Coordination with other projects of the NOAA Climate Assessments and Services Division

We had established early relationships with the RISA group in New Hampshire. Unfortunately this RISA is no longer funded. We have continued to keep Cameron Wake informed of our progress.

III. Accomplishments

A. Brief discussion of research tasks accomplished.

During the past year we reached three main milestones:

1) A preliminary webpage was developed and implemented at http://atmos.eas.cornell.edu/~wrf/ecws/index . At present the website compares storms in terms of their pressure, windspeed and duration relative to the magnitude of the storm surge they produce. These are generated for two tide gauges, one on eastern the other on western Long Island. We have also examined wave height data in a similar manor for a buoy to the south of Long

Island. The website also shows storm tracks and storm surge series for storms that have produced surges in excess of the 95th percentile. This is a precusor for a portion of the web site that will provide analogues storm data for pending real time events. We have also assembled additional tide gauge data sets for two short –term sites on Long Island (Silver Eel Pond and South Jamesport) and sites at The Battery in New York City and Sandy Hook from neighboring New Jersey

2) We have regenerated our original east coast winter storm climatology. In analyzing data for this study we found that many significant flooding events were not associated with storms in our climatology. Further examination revealed that at the coarse 2.5° resolution of the Reanalysis, these storms appeared to not have a northerly component to their motion. This was required by our definition of an ECWS. This criterion was relaxed to allow west to-east motion.

3) We have redeveloped our software to forecast seasonal east coast winter storm activity. In previous work we prescreened a pool of predictors using a Chi squared and retained those that appeared significant. In hindsight, this prescreening compromised the veracity of the statistical results. The initial pool of predictors is now subjected to a principal component analysis, to reduce the number of potential predictors. The retained components now form the basis for season prediction. This change in methodology had little effect on our original results.

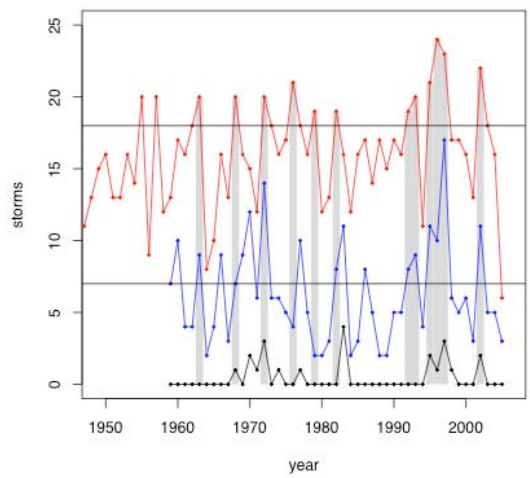
A discriminant analysis-based forecasting technique has been applied to both the storm and tidal surge time series with similar results.

B. **Summary of any preliminary findings**

Our preliminary results are very encouraging. We obtain good skill in forecasting seasonal ECWS activity nearly a year in advance. In general, the strongest single predictor relates to ENSO phase during the previous winter. Almost 80% of the winters with activity in the upper quartile can be anticipated based on this measure. Adding a second predictor representing land and sea surface temperatures over the southeastern United States during the summer preceding the ECWS season, results in over 85% of the “highly active” seasons being identified.

Similar, although slightly weaker predictive skill is obtained for data sets comprising storms of different strengths and when extreme surge occurrence is substituted for storm events. This is an indication that most winter high surge events are related to ECWS and more importantly the probability of experiencing a high surge increases in winters with high ECWS activity.

This last observation is one of the key findings in the research portion of our work. A key goal of our NTRACS funding was to determine whether high ECWS frequency in a particular winter actually resulted in a higher frequency of impacts. Prior work looked solely at storms and not impact producing storms. It does appear that high impacts and high storm frequency are related. The subset of storms that produce greater than 99th percentile storm surges at one of the Long Island area tide gauges can be predicted with similar accuracy (and with the same predictors) as overall storm counts. Despite this coincidence, the figure below shows that this is not always the case.



In the figure storm counts are given by the red line. The blue line shows high surge events that occur in association with storms, while the black line is high surges that do not occur with in association with storms. We have yet to identify the causes of these surges. The gray bands mark years in which storm activity exceeds the upper quartile. Since 1980 each year in which storms exceed the 75th percentile is associated with the occurrence of surge events that also exceed the 75th percentile. A similar, although not as robust, correspondence occurs in the pre-1980 period. At this junction, it is unclear as to whether this difference has a meteorological cause, or if there may be issue associated the quality of the earlier tide data.

C. List of any papers and presentations

None yet

D. Discussion of any significant deviations

We will likely request a 1-year no cost extension. This will be necessary to receive final feedback concerning the products we are developing from our stakeholder groups.

IV. Relevance to the field of human-environment interactions

A. **Furthering the understanding and use of climate in decisionmaking**

Despite coastal impacts that exceed those associated with tropical weather systems, the climatology and impacts of ECWS have received relatively little attention. Through this NTRACS project we intend to provide useful decision support tools related to ECWS frequency and impacts to emergency management and coastal restoration engineers. These tools will highlight historical storm and tide frequencies, provide statistical guidance for anticipating storm activity with a lead-time of one or more seasons, and based on a database of past storm characteristics provide a means by which analogue storms can be ascribed to impending events.

B. Builds on any previously funded CASD research.

Since its inception this work has built upon NSF funded research to quantify annual ECWS frequency, assess the temporal characteristics of ECWS activity, and develop means by which seasonal ECWS frequency could be anticipated. In the last year, we have received additional NSF funds to develop a finer scale ECWS climatology based on the North American Regional Reanalysis dataset and examine the relationship between large scale atmospheric circulation patterns, location of storm origin and potential storm impacts.

C. How is your project explicitly contributing to the following areas?

1. Adaptation to long-term climate change

The 50-climatology of ECWS occurrence, surge extreme frequency and coastal impacts provides a mechanism for assessing changes in these variables over the last half century.

2. Natural hazards mitigation

The work will provide a framework for engineering design specifications that rely on ECWS and storm impact return frequencies and magnitudes.

3. Institutional dimensions of global change

Although the impact of sea level rise on coastal infrastructure in and around the New York City area has received considerable attention, the effects of changes in storm frequency, while acknowledged, have not be treated quantitatively. This work will provide the basis for assessing changes in storm frequency and storm impacts under climate change.

4. Economic value of climate forecasts

Our stakeholders have expressed interest in projections of seasonal storm activity as means of budget management. While it is unlikely that forecast can mitigates the coasts associated with an individual storms. Economic value can be ascribed and quantified to improved knowledge concerning the interannual variations in storm occurrence.

5. Developing tools for decision makers and end-users

We plan to host an operational website by which decision makers can access historical important pertaining to storm occurrence frequency; obtain seasonal projections of storm activity and data regarding the skill of past projections; and assess the potential impacts of impending storms (in real time) based on comparisons with analogue storm events.

6. Sustainability of vulnerable areas and/or people

Not currently applicable.

7. Matching new scientific information with local/indigenous knowledge

Not currently applicable.

8. The role of public policy in the use of climate information

Not currently applicable.

9. Socioeconomic impacts of climate variability, and climate change

These are discussed in items 3 and 4 above.

10. Other (e.g. ways of communicating uncertain information)

VI. Website address for further information (if applicable)

http://atmos.eas.cornell.edu/~wrf/ecws/index.html